T640™ Internet Routing Node

PIC Guide

This guide provides an overview and description of the Physical Interface Cards (PICs) supported by the T640 Internet routing node. The PICs are described alphabetically.

PICs provide the physical connection to various network media types. The PICs are mounted on Flexible PIC Concentrators (FPCs), which insert into a slot in a T640 routing node. The FPC slots are numbered left to right, from FPC0 to FPC7. You can install up to four PICs into slots on each T640-FPC. PICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each PIC performs framing and high-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received from the FPCs. Each PIC is equipped with a media-specific ASIC that performs control functions tailored to the PIC's media type.

A PIC occupies a single slot on a T640-FPC. You can install PICs of different media types on the same FPC, as long as the FPC and the router support those PICs. For example, you can install SONET/SDH OC-48/STM-16, SONET/SDH OC-192/STM-64, and Tunnel PICs on the same FPC of a T640 routing node.

> **Note**
> A single T640-FPC3 has a maximum throughput of 40 Gbps. A single T640-FPC2 has a maximum throughput of 10 Gbps. Inserting a combination of PICs with an aggregate higher than that is supported, but constitutes oversubscription.

Blank PICs resemble other PICs, but do not provide any physical connection or activity. When a slot is not occupied by a PIC, we recommend that you insert a blank PIC to fill the empty slot and to ensure proper circulation of the cooling air.
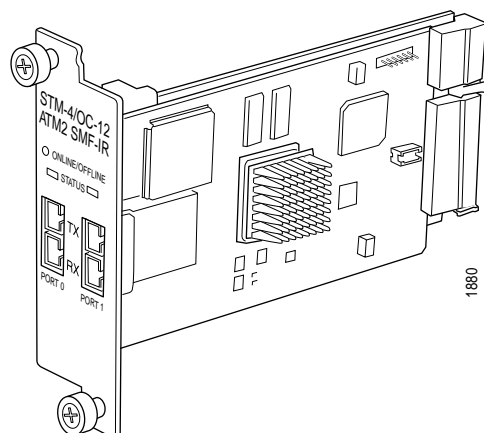
For information about installing and removing PICs, and for information about the T640 routing node, see the *T640 Internet Routing Node Hardware Guide*.

Table 1 lists the PICs supported by the T640 routing node.

Table 1: PICs Supported in the T640 Router

| PIC Family and Type	Ports	First JUNOS Support	FPC Support and PIC Slots Required	Page
ATM2				
ATM2 OC-12	2	5.5	FPC2—1 slot	4
Ethernet				
Gigabit Ethernet	2	5.3	FPC2—1 slot	6
Gigabit Ethernet	4	5.2	FPC2—1 slot	6
Gigabit Ethernet	10	5.5	FPC3—1 slot	6
10-Gigabit Ethernet	1	5.3	FPC3—1 slot	10
SONET/SDH				
SONET/SDH OC-3	4	5.5	FPC2—1 slot	12
SONET/SDH OC-12	4	5.2	FPC2—1 slot	12
SONET/SDH OC-48	1	5.3	FPC2—1 slot	12
SONET/SDH OC-48	4	5.2	FPC3—1 slot	12
SONET/SDH OC-192	1	5.2	FPC3—1 slot	12
Services PIC				
Tunnel Services	0	5.2	FPC3—1 slot	15

ATM2 OC-12 PIC

Description	■ Single-wide PIC that occupies one PIC slot ■ Two OC-12 ports ■ Power requirement: ■ OC-12: 0.52 A/48 V= 25 W ■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 ■ Asynchronous Transfer Mode (ATM) and SONET/SDH standards compliant ■ Alarm and event counting and detection ■ Compatible with well-known ATM switches ■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent FORE ATM switches ■ Optical interface support—see Table 2 on page 5
Software release	■ JUNOS 5.5 and later
Hardware features	■ Dual 3010 SAR ■ High-performance parsing of SONET/SDH frames ■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing ■ 64-MB SDRAM memory for ATM SAR ■ Packet buffering, Layer 2 parsing
Software features	■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC) for leveraging ATM access networks ■ User-configurable virtual circuit (VC) and virtual path (VP) support ■ Support for idle cell or unassigned cell transmission ■ OAM Fault Management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI) cells, and loop cells ■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP ■ Local and remote loopback ■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC) ■ Support for Simple Network Management Protocol (SNMP) management information base (MIB2), ATM MIB, and SONET MIB for each interface ■ Unspecified bit rate (UBR), non-real time variable bit rate (nrt-VBR), and constant bit rate (CBR) traffic shaping ■ Per VC or per VP shaping ■ Support for F4 OAM cells ■ Support for 16-bit VCI range

|	
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Loss of Cell Delination (LoC), Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P)

Table 2: Optical Interface Support for ATM2 OC-12 PICs

PIC Type	Single-Mode Intermediate Reach	Multimode (62.5 Micro)
OC-12/STM-4		
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC duplex connector (length 9.3 miles/15 km)	Multimode with SC duplex connector (length 546.8 yards/500 m)
Wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	−15 through −8 dBm	−20 through −14 dBm
Receiver saturation	−8 dBm	−14 dBm
Receiver sensitivity	−28 dBm	−26 dBm

Gigabit Ethernet PICs
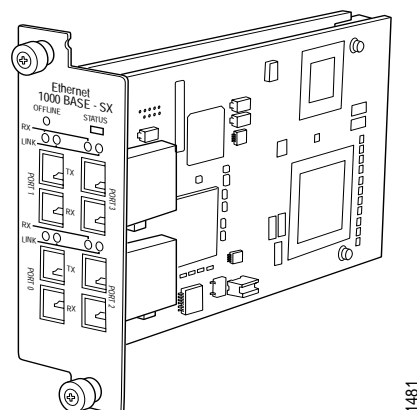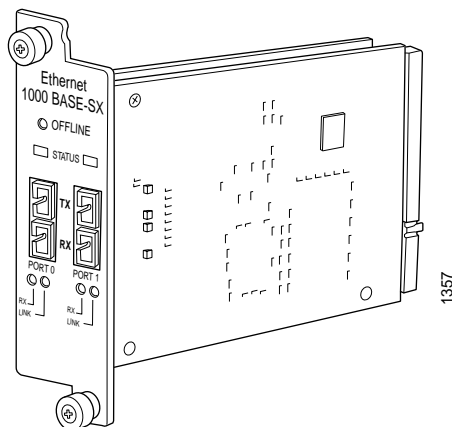
Left: 2-port Gigabit Ethernet; **Right: 4-port Gigabit Ethernet**
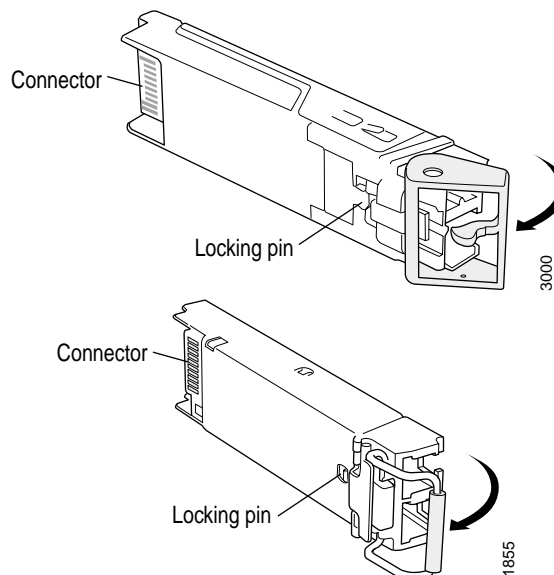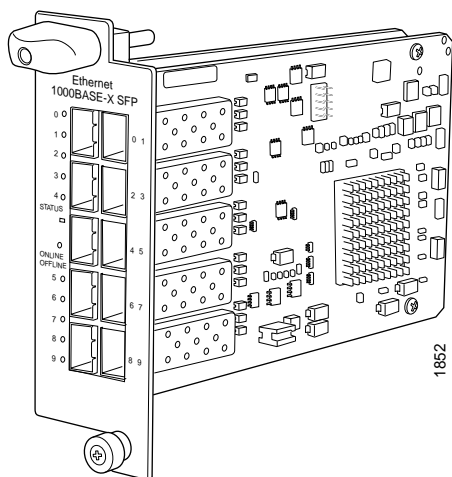
Left: 10-port Gigabit Ethernet; **Right: Examples of Small Form Factor Pluggables**
(Used only in 10-port Gigabit Ethernet PIC)

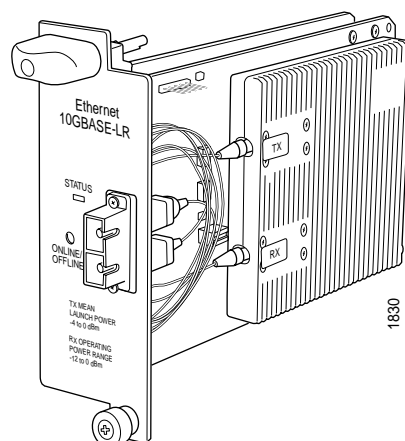|	
Description	■ Single-wide PIC that occupies one PIC slot
	■ Power requirements:
	■ 2-port: 0.33 A/48 V= 15.8 W
	■ 4-port: 0.40 A/48 V= 19.2 W
	■ 10-port: 0.62 A/48 V= 29.9 W
	■ T640 chassis supports three types of Gigabit Ethernet PICs:
	■ Single-wide PIC (two ports), available only for a T640-FPC2
	■ Single-wide PIC (four ports), available only for a T640-FPC2
	■ Single-wide PIC (ten ports), available only for a T640-FPC3
	■ Optical interface support—see Table 3 on page 8
Software release	■ 2-port: JUNOS 5.3 and later
	■ 4-port: JUNOS 5.2 and later
	■ 10-port: JUNOS 5.5 and later

Hardware features	■ High-performance throughput on all ports at speeds up to 1 Gbps
	■ Auto negotiation between Gigabit Ethernet circuit partners
	■ Full-duplex mode
	■ 64 source MAC address filters per port
	■ 964 destination MAC filters per port
	■ Large maximum transfer units (MTUs) of up to 9192 bytes
	Note: If you use a 4-port Gigabit Ethernet PIC on a Juniper Networks M160 router, the MTU will decrease to 4500 bytes.
	■ The 10-port Gigabit Ethernet PIC uses small form factor pluggables (SFPs) that allow different optical interfaces to be used on the PIC. You can use any combination of LX, SX, and LH SFPs. For information about installing and removing SFPs, see the *T640 Internet Routing Node Hardware Guide*.
	■ The 10-port Gigabit Ethernet PIC supports three types of SFP optical interfaces:
	  ■ SX—ejector handles are beige or black
	  ■ LX—ejector handles are blue
	  ■ LH—ejector handles are green

Software features	■ Virtual Router Redundancy Protocol (VRRP) support ■ 802.1Q virtual LANs (VLANs) support ■ RMON EtherStats

Cables and connectors	**2-port and 4-port PICs:**
	  ■ Duplex SC connector (TX and RX)
	10-port PIC:
	  ■ Duplex LC connector (TX and RX)

LEDs	**2-port and 4-port PICs:**
	■ Status LEDs, one two-color:
	  ■ Off—PIC not enabled
	  ■ Green—PIC is operating normally
	Note: A normal status appears on the 4-port Gigabit Ethernet PIC's LED when at least one port is online.
	  ■ Red—PIC has an error or failure
	■ Port LEDs, one pair per port:
	  ■ Link—If green, the port is online; no light means the port is down
	  ■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data
	10-port PIC:
	■ Status LEDs, one-tri-color:
	  ■ Off—PIC not enabled
	  ■ Green—PIC is operating normally
	Note: A normal status appears on the 10-port Gigabit Ethernet PIC's LED when at least one port is online.
	  ■ Amber—PIC online with alarms for remote failures
	  ■ Red—PIC active with a local alarm; router has detected a failure
	■ Port LEDs, one per port:
	  ■ Off—Port is down
	  ■ Green—Link is established

Table 3: Optical Interface Support for Gigabit Ethernet PICs

PIC Type	SX Transceiver	LX Transceiver	
2-port and 4-port			
Optical interface	2- and 4-port: SX (IEEE 802.3 compliant) with SC duplex connector (length 656-ft/200-m on 62.5/125 micrometer multimode fiber (MMF) or 1640-ft/500-m on 50/125 micrometer MMF)	2-port: LX (IEEE 802.3 compliant) with SC duplex connector (length 6.2-mile /10-km on 9/125 micrometer singlemode fiber (SMF) or 1804.5-ft / 550-m on 62.5/125 and 50/125 micrometer multimode fiber (MMF))	
Wavelength	830 through 860 nm	1270 through 1355 nm	
Average launch power	−9.5 through −4 dBm	−11 through −3 dBm	
Receiver saturation	−3 dBm	−3 dBm	
Receiver sensitivity	−17 dBm	−19 dBm	
10-port	**SX Transceiver**	**LX Transceiver**	**LH Transceiver**
Optical interface	SX (IEEE 802.3 compliant) with LC duplex connector (length 656-ft/200-m on 62.5/125 MMF or 1640-ft/500-m on 50/125 micrometer MMF)	LX (IEEE 802.3 compliant) with LC duplex connector (length 6.2-mile /10-km on 9/125 micrometer SMF)	LH (IEEE 802.3 compliant) with LC duplex connector (length 49.5-mile /70-km reach on 9/125 micrometer SMF)
Wavelength	830 through 860 nm	1275 through 1350 nm	1480 through 1580 nm
Average launch power	−9.5 through −4 dBm	−9.5 through −3 dBm	−3 through + 3 dBm
Receiver saturation	−3 dBm	−3 dBm	−3 dBm
Receiver sensitivity	−18 dBm	−20.5 dBm	−23 dBm

(Continued on next page)

10-Gigabit Ethernet PIC

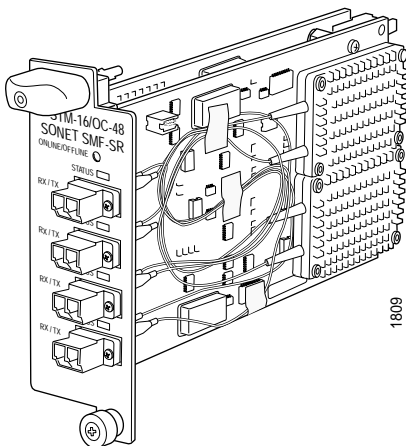| Description	■ Single-wide PIC that occupies one PIC slot
	■ One 10-Gigabit Ethernet port on a T640-FPC3
	■ Power requirement: 0.74 A/48 V= 35.5 W
	■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network
	■ Optical interface support—see Table 4 on page 11
Software release	■ JUNOS 5.3 and later
Hardware features	■ High-performance throughput at speeds up to 10 Gbps
	■ Auto negotiation between 10-Gigabit Ethernet circuit partners
	■ Full-duplex mode
	■ Large MTUs of up to 9192 bytes
	■ 64 source MAC address filters per port
	■ 964 destination MAC filters per port
Software features	■ Virtual Router Redundancy Protocol (VRRP) support
	■ 802.1Q virtual LANs (VLANs) support
	■ RMON EtherStats
Cables and connectors	■ Duplex SC connector (TX and RX)
LEDs	Status LEDs, one two-color:
	■ Off—PIC not enabled
	■ Green—PIC is operating normally
	■ Red—PIC has an error or failure
	Port LEDs, one pair per port:
	■ Link—If green, the port is online; no light means the port is down
	■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data

Table 4: Optical Interface Support for 10-Gigabit Ethernet PICs

PIC Type	Long wavelength serial, LAN rate
10-Gigabit Ethernet	
Optical interface	Long wavelength serial, LAN rate (IEEE 802.3ae compliant) with SC duplex connector (length 6.2-mile /10-km on 9/125 micrometer single-mode fiber)
Wavelength	1260 to 1355 nm
Average launch power	−4 through 0.5 dBm
Receiver saturation	0.5 dBm
Receiver sensitivity	−10.3 dBm

SONET/SDH PICs
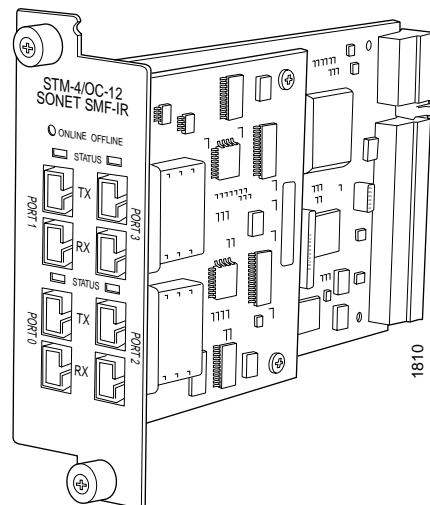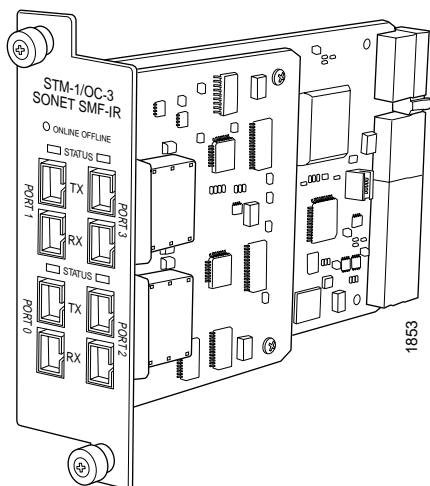
Left: SONET/SDH OC-3; Right: SONET/SDH OC-12
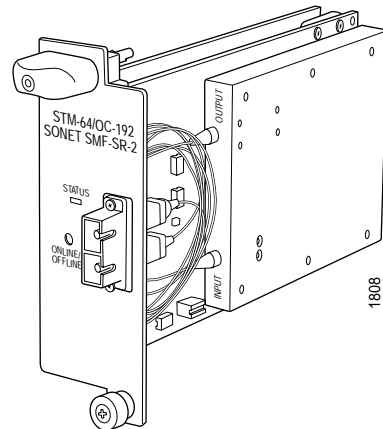
Left: SONET/SDH OC-48; Right: SONET/SDH OC-192

Description	■ Single-wide PIC that occupies one PIC slot
	■ Supports OC-3, OC-12, OC-48, and OC-192 line speeds
	■ Power requirements:
	■ OC-3: 0.49 A/48 V= 23.7 W
	■ OC-12: 0.49 A/48 V= 23.7 W
	■ OC-48 1-port: 0.86 A/48 V= 41.4 W
	■ OC-48 4-port: 0.62 A/48 V= 29.8 W
	■ OC-192: 0.45 A/48 V= 21.5 W
	■ Perform multiplexing and demultiplexing
	■ Optical interface support—see Table 5 on page 14
Software release	■ OC-3: JUNOS 5.5 and later
	■ OC-12: JUNOS 5.2 and later
	■ OC-48 1-port: JUNOS 5.3 and later
	■ OC-48 4-port: JUNOS 5.2 and later
	■ OC-192: JUNOS 5.2 and later

Hardware features	■ High-performance throughput on all ports with advanced services and features enabled ■ High-density interface concentration ■ No input buffering delay ■ Rate policing on input ■ Rate shaping on output ■ Packet buffering, Layer 2 parsing
Software features	■ SONET/SDH framing ■ Alarm and event counting and detection ■ Dual-router automatic protection switching (APS) and Multiprotocol Label Switching (MPLS) Fast Reroute protection ■ Encapsulations—Frame Relay, High-Level Data Link Control (HDLC), MPLS circuit cross-connect (CCC), Point-to-Point Protocol (PPP)
Cables and connectors	■ Duplex SC connector (TX and RX) ■ Duplex LC connector (TX and RX) ■ MTP connector (TX and RX)
LEDs	One tricolor per port: ■ Off—Port not enabled ■ Green—Port online with no alarms or failures ■ Amber—Port online with alarms for remote failures ■ Red—Port active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm Indication Signal (AIS-L, AIS-P) ■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF) ■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored Seconds (ES-S, ES-L, ES-P), Far-end Bit Errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end Errored Seconds (ES-LFE, ES-PFE), Far-end Severely Errored Seconds (SES-LFE, SES-PFE), Far-end Unavailable Seconds (UAS-LFE, UAS-PFE) ■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS) ■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P) ■ Remote Defect Indication (RDI-L, RDI-P) ■ Severely Errored Framing (SEF), Severely Errored Framing Seconds (SEFS-S), Severely Errored Seconds (SES-S, SES-L, SES-P), Unavailable Seconds (UAS-L, UAS-P)

Table 5: Optical Interface Support for SONET/SDH PICs

PIC Type			
OC-3/STM-1	**Single-mode Intermediate Reach**		**Multimode**
Optical interface	Single-mode, intermediate reach (Bellcore GR-253-CORE compliant) with SC duplex connector (length 9.3 miles/15 km)		Multimode with SC duplex connector (length 1.2 miles/2 km)
Wavelength	1260 through 1360 nm		1270 through 1380 nm
Average launch power	−15 through -8 dBm		−20 through −14 dBm
Receiver saturation	−8 dBm		−14 dBm
Receiver sensitivity	−28 dBm		−30 dBm
OC-12/STM-4	**Single-mode Intermediate Reach**		**Multimode**
Optical interface	Single-mode, intermediate reach (Bellcore GR-253-CORE compliant) with SC duplex connector (length 9.3 miles/15 km)		Multimode with SC duplex connector (length 546.8 yards/500 meters)
Wavelength	1274 through 1356 nm		1270 through 1380 nm
Average launch power	−15 through −8 dBm		−20 through −14 dBm
Receiver saturation	−8 dBm		−14 dBm
Receiver sensitivity	−28 dBm		−26 dBm
OC-48/STM-16	**Single-mode Short Reach**		**Single-mode Long Reach (1-port PIC Only)**
Optical interface	Single-mode, short reach (Bellcore GR-253-CORE compliant) with SC duplex connector (1-port PIC) or LC duplex connector (4-port PIC) (length 1.24 miles/2 km)		Single-mode, 1500 nm long reach (Bellcore GR-253-CORE compliant) with SC duplex connector (length 49.71 miles/80 km)
Wavelength	1266 through 1360 nm		1500 through 1580 nm
Average launch power	−10 through −3 dBm		−2 through + 3 dBm
Receiver saturation	−3 dBm		−9 dBm
Receiver sensitivity	−18 dBm		−28 dBm
OC-192/STM-64	**Very Short Reach**	**Single-mode Short Reach 2**	**Single-mode Long Reach**
Optical interface	VSR optical interface; compatible with 12-ribbon multimode fiber with MTP connector (length 984.25 ft / 300 m)	Single-mode, short reach 2 (Bellcore GR-253-CORE compliant) with SC duplex connector (length 12.4 miles/20 km)	Single-mode, 1500 nm long reach (Bellcore GR-253-CORE compliant) with SC duplex connector (length 49.71 miles/80 km)
Wavelength	830 nm through 860 nm	1530 through 1565 nm	1530 through 1565 nm
Average launch power	−10 through −3 dBm	−4 through −0 dBm	+ 6 through + 8 dBm
Receiver saturation	−3 dBm	−3 dBm	−10 dBm
Receiver sensitivity	−16 dBm	−14 dBm	−22 dBm

Tunnel Services PIC

Description	■ Single-wide PIC that occupies one PIC slot ■ Power requirement: 0.07 A/48 V= 3.41 W
Software release	■ JUNOS 5.2 and later
Hardware features	■ Loopback function that encapsulates and de-encapsulates packets
Software features	■ Aggregate SONET/SDH OC-192/STM-64 tunneling bandwidth ■ IP-IP unicast tunneling ■ GRE unicast tunneling ■ PIM sparse mode unicast tunneling
LEDs	One tricolor: ■ Off—PIC not enabled ■ Green—PIC online with no alarms or failures ■ Amber—PIC online with alarms for remote failures ■ Red—PIC active with a local alarm; router has detected a failure